ON INDIAN PARASITIC FLIES.

BY

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I

This paper is concerned with parasitism among Diptera and particularly among Indian flies. Of the dozen or thirteen families of two-winged flies, in which parasitic habits have been developed, all but one are represented in the insect fauna of India. In some cases it is the larva, in others the perfect or winged insect, which is a parasite. There are also cases of wingless flies, which pass the whole of their existence on the bodies of the hosts from which they draw their nourishment. By no means all blood-sucking flies are parasites; for parasitism, in the strict sense, implies that a host is essential to the well-being and development of the parasite. On the other hand all Diptera which are parasitic in the imaginal, or final, stage of their lives, are blood-suckers. When the respective life-histories of an Œstrid and a Hippoboscid fly are contrasted, it will be seen how entirely larval parasitism differs from imaginal parasitism and what adaptations have been developed to secure the well-being of the larva and the perfect insect, respectively.

By way of preface some generalities on two-winged flies are necessary to render intelligible what follows on the parasitic species. The Diptera are physiologically among the highest insects; none get through their life-history more rapidly; and no insects go through such a complete metamorphosis as flies. In the Muscid flies we have the most highly specialised imago and the most degraded larva known in any group of insects. The larvæ are usually called grubs or maggots. Thoracic legs are always absent; but many larvæ have pseudopods by which they move about with great facility.

Diptera may at once be recognised by the presence of only one pair of wings. The second or hind pair are represented by poisers or balancers called *halteres*, which are small organs consisting of a stem and a knob. The halteres are, obviously, homologous with wings; and in the parasitic wingless forms they usually disappear along with the wings. They vibrate during flight, and besides acting as balancers, they also serve as sense organs. The basal part is supposed to contain a structure which allows sound to be perceived. The wing veins, which are of great taxonomic importance, are comparatively few and for the most part run longitudinally. If the halteres represent wings, it is remarkable that no organs intermediate between the two should be found in any Dipteron. The thorax is welded into a single mass instead of being composed of three clearly divided segments. The legs are characterised by five-jointed tarsi and are often long and slender. In the purely parasitic *Hippoboscidæ* they tend to become shorter but exceedingly stout. The foot of a fly is composed of a

pair of claws and a pair of pads between them. The claws may be extremely slender but in parasitic flies they tend to become strong and serrated.

The antennæ of flies show much variety and have, since the days of Latreille (1802), been regarded as furnishing fundamental characters for classification. They are of two types. The primitive type of antenna is *Nematocerous* (which means long-horned) and consists of a number of nearly similar joints. The *Brachycerous* (or short-horned) type appears to consist of only three joints dissimilar from one another. On closer examination the last is seen to be more or less distinctly ringed and to be made up of several joints. The complex antenna of the most highly specialised flies has, in fact, been evolved from the simple Nematocerous antenna by a concentration of the basal joints and an elongation of the distal. In the parasitic flies this latter type of antenna is very much reduced. Sometimes only a single joint with a few bristles is recognisable ; and this is sunk in a deep pit on the head from which it can be protruded by the contraction of the muscles at the base.

This is no place to enter into the controversies that have raged around the homologies of the dipterous mouth parts. The fly's mouth is adapted for sucking and, sometimes, for piercing and sucking. The mouth parts project beyond the head and form a more or less cylindrical proboscis. In some of the parasitic Hippoboscid flies the proboscis can be almost completely withdrawn within the head. Whilst in the Œstrid flies, in which the larva is parasitic and the perfect insect does not feed, the mouth parts are rudimentary or absent. In all typical flies the proboscis is formed of the *labium*, or lower lip which encloses and sheaths the other parts, which may be variously modified and some of which may be absent.

The reader, who knows anything of entomology, need only be reminded that the order Diptera is divided into two large groups or sub-orders the *Orthorrhapha* and *Cyclorrhapha*. The main difference between these two groups turns upon the manner in which the insect emerges from the pupal envelope. In the *Orthorrhapha* the pupa is mummy-like and shows, in outline, the parts of the future imago which escapes by splitting the skin down the back. In the *Cyclorrhapha* the pupa is like a small barrel, showing only rings outside and nothing of the future imago within. The fly emerges by pushing off a circular cap. The group of flies known as *Pupipara*, because the larva is retained within the mother's body and there nourished until it is ready to pupate, are Cyclorrhaphous flies much modified by parasitism.

The connection that, apparently, exists between development of squamæ or tegulæ and parasitic habits deserves attention. It seems to be chiefly those groups containing a large proportion of entoparasitic species that are provided with tegullæ ; and it is possible that

an acuter sense of hearing is necessary to those forms in their search for hosts. The *Cyrtidæ* for instance are a group which have developed extremely large tegulæ which conceal the halteres and are probably accessory to a highly developed auditory sense. In Diptera auditory organs are placed at the base of the wings and may well be sensitive to air-waves which make no impression on our ears. The halteres in Diptera are supplied by nerves only second to the optic nerves which are the largest in the insect's body. The tegulæ of Diptera are very possibly functional in collecting sound waves and increasing the perceptive power of the organs in the halteres. It seems safe to assume that in those dipterous groups which have no tegulæ, the halteres chiefly perform a function of equilibration ; but in those groups which have highly developed tegulæ such as *Cyrtidæ*, *Tachinidæ* and most *Œstridæ*, the halteres are mainly organs of hearing. So the presence of large well-developed tegulæ in the parasitic flies indicates the presence of a highly developed auditory sense in the halteres. The tegulæ, if this view is correct, are analogous with the cartilaginous external ears of mammals.

Between 40,000 and 50,000 species of Diptera have been described and these have been distributed by modern systematists into about 60 families. The life histories of the parasites are among the most amazing things in Nature. Diptera are not popular insects even among entomologists. Beelzebub in Hebrew is the Prince of Flies but protects his votaries from the molestations of these pests. If this paper should induce one person in India to become a collector of Diptera or, better still, an investigator of their life histories, about many of which nothing is known, it will not have been written in vain.

It will be convenient to show in the form of a table the families of Diptera in which parasitic habits have been developed.

DIPTERA.

I. *Orthorrhapha.*		
Nematocera ..	None are parasitic.	
Brachycera ..	*Bombyliidæ Cyrtidæ = Acroceridæ*	Larval parasitism.
II. *Cyclorrhapha.*		
Aschiza ..	*Phoridæ*	Larval parasitism in many members of these groups.
,, ..	*Pipunculidæ* ..	
Schizophora ..	*Conopidæ*	
,, ..	*Tachinidæ*	
,, ..	*Dexiidæ*	
,, ..	*Muscidæ*	
,, ..	*Sarcophagidæ* ..	
,, ..	*Œstridæ*	

Section Pupipara. ..	*Hippoboscidæ* ..	..	Imago parasitic.
	Streblidæ ..	..	
	Nycteribiidæ ..	..	
	(*Braulidæ*) ..	..	

Various considerations, interesting to the student of parasites, will occur to the reader who thinks over the facts disclosed by this table. In the first place it will be noted that parasitism is far more prevalent in the *Cyclorrhapha* than in the more primitive *Orthorrhapha*. Indeed in the Nematocerous division, which includes the most primitive flies known, there are no parasitic species at all; and in the Brachycerous division only two families, neither of which are very large ones. This absence of parasites from the primitive groups of Diptera is confirmation of Metchinkoff's dictum: that among parasites we are to look for the latest products of evolution.

In the second place, it will be noted that parasitic *larvae* and parasitic *imagines* are sharply contrasted and separated. Only in the Pupipara do we find adult flies parasitic on mammals and birds. Larval parasitism is far more widely spread. The nourishment of the individual and the reproduction of the species is the aim and end of all animals. In insects the larval stage is the period of feeding and of growth; the imaginal stage is the period of love and procreation. Now parasitism is ultimately a matter of securing nourishment. The parasite solves the problem of nutrition, but is often confronted with difficulties when the problem of reproduction has to be faced. This explains why in Diptera, to deal only with the one order under review, the feeding-stage, rather than the reproductive, should more commonly be the parasitic stage. It is an advantage to a larval fly to be well supplied with food and, as an incident, to be a parasite. It is equally an advantage to a mature fly to be free living, and to move about seeking the other sex or depositing eggs. The breeding habits of the Pupipara, which do not lay eggs and nourish the larva within the maternal abdomen, enable the mature fly to enjoy the advantages of a parasitic life. There is no free larval stage to be considered; but against this, nourishment for the adult fly is essential, for without it the young could not be reared. As a result the adult fly is parasitic.

There are other reasons why the larval stage should be parasitic. The habits of Diptera easily pass over into parasitism; but this involves some changes in the way of life which probably come more easily at an immature stage, whilst development and growth are in progress. The greater number of dipterous larvae are vegetable feeders, but many live on decomposing animal matter. From this it is but a step to live and feed in and on the living bodies of other insects or snails, reptiles, birds and mammals. For obvious reasons no dipterous larva is known to be parasitic in a fish. The

dipterous larva, whether free or a parasite, always finds itself among rich supplies of food. For this it must thank its mother who has had a wonderful instinct and in some cases the needful specially adapted ovipositor. This explains why in the Diptera, particularly those in which the larva is parasitic, we find perfect instinct and perfect structure in the imago coupled with comparative degradation in the larva. Hence also arises the vast transformation which takes place at the pupal stage.

II

I propose now to give some account of the structure and life-history of the species which compose the families with parasitic larvae. It will be possible to take a survey of the varieties of hosts that are attacked, of the adaptations which these Dipterous families have evolved in connection with their parasitic habits, and of the most common representations of each family in India. The *Pupipara* will best be treated as a group by themselves; though some entomologists regard the group as polyphyletic and none are agreed what value should be accorded to it. The families which compose the *Pupipara* have little in common except habits. Two of the families are parasites of bats and therefore unfamiliar to most people but to the lover of parasites much the most interesting of all Diptera. In the preceding table I have enclosed *Braulidae* in brackets because the pupiparous habits of the single species are doubtful. It is a minute insect found clinging to bees and not recorded from India.

Bombyliidæ. These conspicuous flies are members of a large cosmopolitan family and may be recognised by their habit of remaining poised for some minutes in the air and then darting away. All are lovers of sunshine and many are frequenters of arid, sandy places. They are familiar features in the Indian plains.* Many attain considerable size and some are gorgeously coloured and coated with fur. The wings are often prettily marked. This family contains many of the most brilliantly coloured Diptera. The abdomen in the subfamily *Bombyliinæ* is almost globular and clothed with a dense furry pubescence like a bumble-bee. The adult flies frequent flowers and feed on honey and pollen. The larvæ feed parasitically on the larvæ of other insects, in some cases Lepidoptera and Hymenoptera, in others on Diptera (Tachinids) which are themselves parasitic on lepidopterous larvæ. The female fly is not provided with any specially adapted ovipositor for placing the eggs which are dropped from above haphazard in the vicinity of the larval host. The Bombyliid larva is amphineustic and cylindrical, with thirteen segments.

* A description of the Indian genera and species will be found in the recent (1920) volume of "The Fauna of British India" *Diptera Brachycera*, by E. Brunetti, Vol. I. pp. 173-295.

It has a small retractile head with well-developed mouthparts, papillate antennae and no eyes. When full fed it pupates where it lies and turns into a mummy-like pupa often with strong spines on the head and anterior parts. These spines are appliances developed in connection with the larva's parasitic life to enable the imago to reach the open air.

Most of what is known as to the parasitic habits of these flies we owe to the French entomologist Fabre. *Argyramœba* Sch. is a widely distributed genus with thirteen India species. Fabre's account relates to *A. trifasciata* Mg. which is parasitic on larval masonbees. These bees (*Chalicodoma*) make mud nests on walls and roofs. The parent Bombyliid drops an egg on the nest whilst hovering over it. From this an extremely minute and slender larva is hatched. For a fortnight it remains quiescent and fasting. Then it shows unexpected endurance for one that has fasted so long and amazing pertinacity in seeking a way into the chamber where the larva mason-bee is lying. The Bombyliid larva has a deflexed horny head with stiff bristles. Four pairs of long setae serve as organs of locomotion. By dint of searching it discovers some crack in the masonry through which it can insinuate its small body. Fabre likens this persistence to the root of a plant working its way through a wall to seek nourishment. This primary form of the larva enables the parasite to reach its victim. Once within reach of food it grows, becomes obese and the setae disappear. The parasite feeds on the host, without killing it, by applying a delicate sucker-like mouth to different parts of the body in turn. At the end of 12 or 15 days the parasite is full grown and the host is reduced to an empty shell. For some months the larva remains quiescent and in the following spring it pupates. Then comes the crisis, for the Bombyliid fly must reach the outer world. Neither the larva, nor the imago has organs capable of doing the work of excavation which is needed and the haircrack which admitted the fasting larva will not permit an exit to the full-fed animal. The Bombyliid pupa, however, has the necessary appliances: (*a*) on the anterior part, spines (*b*) on the middle segments, rigid hairs directed backwards (*c*) on the posterior part, horns. The pupa as a whole is curved into a crescent; and having fixed itself in a firm position by the posterior horns it digs a gallery, by which it can escape, using the head-spines as picks. The pupal skin bursts when an exit has been effected; the fly emerges leaving the skin sticking in the mouth of the gallery.

Bombylius L. is a large genus with a world-wide distribution. This genus is parasitic on small bees (*Andrena* and *Halictus* and others) which live in colonies in sand banks. From India ten species have been collected. *B. major* L. is not at all uncommon on the Simla hills and *B. orientalis* Macq. is found all over India. *B. major* has

been observed to jerk its eggs against a sand bank, from the distance of an inch or more yet strangely enough not so as to drop them actually into the burrow of any bee.* The larvae are of Hymenopterous aspect but there is no mistaking the Dipterous head. The pupa has most remarkable cephalic spines which act as digging organs. There are five prongs on the ventral surface of the head which have been likened to the tusks of a walrus. No part of the imago is formed in these spines and they serve, when the time for emergence comes, to tear down the clay stopping with which the bees close their burrows. Without such tools for digging a way out of the earth, the parasitic larva would have lived in vain.

This family is represented by a hundred described species in India. *Anthrax* Scop., *Exoprosopa* Macq. and *Hyperalonia* Rond. are the largest genera besides those mentioned already. In many cases the life-history is unknown. *Geron argentifrons* Brun. is parasitic on caterpillars found under the bark of the Sissoo-tree (*Dalbergia sissoo*). The pupa of a species of *Systropus* Wied. has been found inside the cocoons of a moth. At one end of the moth's cocoon is a circular piece which is easily removed and allows the perfect insect to escape. The pupal *Systropus* has a strong frontal projection apparently used for the purpose of forcing off this lid. When one considers the difficulties which meet the emerging Bombyliid fly, especially when masonry or clay-stopping has to be penetrated, one cannot but wonder what percentage fail to get out and to perform their reproductive work.

Cyrtidæ. This is quite a small family of rather small flies with curious habits and often an unusual appearance. They are sometimes called *Acroceridæ* but the former name is used by the best authorities whose judgment I follow. The range of the family is world-wide but only some 200 species are named and of these 10 have been collected in India, *Oncodes*, Latr. being the most important genus in that region.* The family is allied to the *Bombyliidæ*; but whereas the latter are parasitic on insect larvae, all the *Cyrtidæ*, whose metamorphoses and life-histories are known, have larvae which are parasitic in the abdomens or in the egg-cocoons of spiders. The perfect insects are like caricatures of *Bombylius* with a head that seems to consist of nothing but enormous globular eyes, a humped thorax and a rounded, sometimes actually globular, abdomen. The mouth-parts are so varied that one can draw no conclusion as to the food that is taken if any. In *Acrocera*, there is a long slender proboscis but in *Oncodes*, the proboscis is apparently absent and there is no orifice into the mouth so that all the feeding must be done during

* Chapman, "On the economy of *Bombylius*." Ent. Mo. Mag ((1878) Vol. 14, p. 196.

For the Indian genera and species see "Fauna of British India." *Diptera Brachycera* by E. Brunnetti, Vol 1, which appeared in May 1920.

the larval stage which to the parasitologist is the interesting stage. The eggs are laid by the flies on the stems of plants and when the young larvae emerge they must reach a spider. It is perhaps for this purpose, that they are endowed with unusual leaping powers. They are amphineustic, short, thick, 12-segmented with small head and smaller mouth parts. They burrow into the abdomen of the spider and feed on the tissues. When full fed the larva eats a way out and the dried skins of the spiders are found with a circular orifice clearly showing what has happened. The larva then pupates and the pupa lies in the spider's web until the fly emerges. Not having to dig itself free like the members of the previous family, the Cyrtid pupa has no cephalic spines but on the dorsum of the thorax there is a longitudinal row of spines the use of which is unknown.

One matter in connection with the respiration of the parasitic larva deserves to be mentioned. The hind spiracles are surrounded by large and peculiar plates. Respiration is a matter which must always present a problem for the internal parasite. In one case the Cyrtid larva has been found lying in the abdomen of the host (a spider of the genus *Cteniza*) with the terminal spiracles actually in the lungs of the spider from which it, doubtless, obtained its oxygen. * When the flies emerge from the pupa they frequent flowers and grass. They have rather small wings and no great powers of flight. The halteres are quite concealed by large horizontal squamae which have been previously referred to.

Phoridæ. This is an interesting family of small black and yellow flies with varied and remarkable habits. They have been collected from most parts of the world and are common in India, more so perhaps in the hills than in the plains. They have a hunch-backed appearance, well developed legs and as a rule well developed wings though there are some wingless forms. Most frequently they are to be found about decaying vegetable matter and fallen leaves but sometimes on windows. Little is known about the habits of most species and Brues, the leading authority on the family, has no doubt that much of interest awaits anyone who may undertake to study the varied habits of this group. Brues recognises 23 genera. This is an isolated group whose systematic position is unsettled and Dahl has contended that the *Phoridæ* show affinities with fleas.

To the student of parasitology the larvae are of exceptional interest because some get their nourishment from dead and decomposing

* An interesting account and plates of larvae, etc., will be found in: "Beiträg. zur Biologie der Acroceriden" (*Cyrtidæ*) by F. Brauer. Verh. Zool-Bot. Ges. Wien (1869) Vol. 19 p. 737. See also the same author's later paper (1883) Denks. Ak. Wiss. Wien, Vol. 47 at p. 26 and p. 61.

Wytsman's "Genera Insectarum": Part 43. *Phoridæ* by C. T. Brues. There is also a Monograph by Theodor Becker Abh. Zool.-Bot. Ges. Wien. (1901) Vol I. Heft 1.

animal matter, but others do so whilst living in or on live animals some as parasites, others as commensals. A study of the habits of allied species as they advance along the road to parasitism ought to throw light on the gradual stages by which the strictest parasitic habits have been evolved. The Phorid larvae are cylindrical and tapering towards the front. All that had then been observed as to life habits and metamorphoses was collected in 1883 by Brauer. * From this it appears that the larvae, as a rule, live in other insects (both living and dead) as well as in almost any sort of decaying organic matter. Certain species show a predeliction for human corpses. It seems established that each individual species of larva is not inseparably bound to any definite host or even to any special sort of nourishment. The most varied habits have been observed in one and the same species. From this it may be inferred that parasitism, where it occurs, is a newly acquired habit. A number of Phorid larvae live in ants nests. *Apocephalus* is a parasite and *Metopina* is commensal. The parasitic larva lives in the head of the adult ant which finally drops off. The commensal larva lives curled about the neck of the larval ant and partakes of the food given by the attendant worker ants. Other Phorids have attached themselves to termites, while others are found in the nests of fossorial bees and wasps. It would be instructive to know what they do and what they feed on in the nests.

Pipunculidæ. This is a small family of rather obscure and minute flies; but they are found in most portions of the globe and there are a number of Indian species which have been very little studied. So far as their habits are known the larvae are always parasitic in the bodies of Rhynchota. The Homopterous leaf-hoppers belonging to the families *Jassidæ* and *Fulgoridæ* are much attacked and also the spittle-insects or *Cercopidæ.* The important genus is *Pipunculus* Latr. with about 80 described species represented in every continent. Verrall considers the family the most exquisite fliers in the order Diptera. They can remain poised, without ever touching the sides in a glass tube not more than half-an-inch across. This power is made use of by the female when laying her eggs on the Homopterous host. She has been observed beating to and fro over the herbage and then, on perceiving the species of insect for which she was searching, hovering motionless like a kestrel and finally pouncing when the position of the victim was favourable.

To assist in this parasitic business the flies have developed at least three sets of interesting features. First come the enormous eyes. The head is nearly spherical, actually broader than the thorax, and composed chiefly of the large eyes. The front facets, which in both

* Dr. F. Brauer 'Die Zweiflügler des Kais. Museums zu Wien'. Denks. Kais. Ak. Wiss. Wien. (1883) Vol. 47, at p. 66.

sexes are well developed, are enlarged to an enormous extent in the females. The proboscis is concealed and nothing of the head is visible in some species except the antennae and the globular eyes. The head reaches its maximum development among Diptera in this family, and being balanced on a point, a high degree of mobility is attained. It is clear that vision is principally depended on in finding a host for the egg.

Secondly, legs and feet are unusually well developed and strong. The feet are furnished with large laminate pulvilli and slender elongated claws. The fact that in some species they are larger in the female than in the male shows that they are implements to serve the female in her egg-laying; for when she pounces on her victim she graps and holds it, remaining perched upon its back, until her purpose is effected. Lastly, the ovipositor of the female is a noteworthy feature. It is strong and prominent, forming a sharp recurved, piercing-organ. The egg-laying is effected with great rapidity. It seems to be established that some flies will attack different species of leaf-hopper but whether hosts from different families, *e.g.*, *Fulgoridæ* or *Zassidæ* are used by the same Pipunculid species is uncertain. Both adult leaf-hoppers and nymphs are subject to attack.

Out of the egg emerges a small, thick, oval larva which feeds on the living tissues of the host, without killing it, and which may sometimes be seen through the cuticle. The Pipunculid larva ultimately leaves its host, to pupate buried in the soil or attached to a leaf of the tree on which the leaf-hopper fed. Although a shapeless acephalous maggot it is capable of great extension and contraction. By which means, and by rolling movements, it is able to make enough progress to find a place suitable for pupation. When the larva of *Pipunculus* leaves the host it usually escapes at the junction of the thorax and abdomen and this rupture of the leaf-hopper proves fatal to the host.* The pupa is black or brown and of the normal dipterous type. The life history of this interesting family deserves much closer study for we have a dipterous family which in behaviour and habits approaches in several respects the highly specialized parasitic Hymenoptera. Little is known in India of the family as a whole but Brunetti has described some Indian species and the family is one which would well repay collectors.

Conopidæ. This is another comparatively small family but one with a wide geographical distribution. The larvae have a remarkable parasitic career. The adults frequent flowers, fly rather slowly,

* Some details on life history will be found in 'Leaf-Hoppers and their Natural Enemies (Part IV. *Pipunculidæ*) By R. C. L. Perkins, Honolulu 1905. The European *Pipunculidæ* have been monographed by R. Becker, Berliner Ent. Zeitsch. (1897) Vol. 42 p. 25. With an excellent plate of the forms of ovipositor. The larva is described by F. Brauer "Die Zweiflügler des Kaiserl. Mus. zu Wien." Denks Kais. Ak. der Wiss. Wien (1883) Vol. 47 p. 32. All the above works contain references to earlier papers.

and being coloured yellow, red, or black, with a distinct waist and a pubescent abdomen, they have an unusual resemblance to wasps which may be protective. In India they are often to be seen in the hills, but are not so common in the plains. *Conops erythrocephala* with a black abdomen and grey thorax and head is a widely distributed Indian species. Most species are elongated flies of moderate size and the ovipositor of the female is often conspicuous. In some cases it is folded beneath the abdomen, in others not.

The parasitic life of the larva is passed, so far as is known by nearly all species, in the body of adult Hymenoptera, wasps and bees. Occasionally the larvae of this family are parasitic on Orthoptera.* In some cases the Conopid fly has been seen pursuing a wasp or bee and depositing eggs directly on its body during flight. When the larva emerges, it burrows into the abdomen of the bee or other host. It lives within the abdominal cavity of the host and feeds on the least vital parts, lying with its posterior end directed towards the base of the abdomen. It is an oval larva, distinctly segmented, with strongly bent mouth-hooklets at one end, and at the other, on the last segment, two large round stigmatic plates arched like watch-glasses. The larva pupates within the host and remains there during the winter. When the time arrives for the adult fly to emerge, it forces a way out between the abdominal segments. Whether this proves in all cases fatal to the unfortunate bee, appears not to be certainly known.† A number of cases are on record where collectors of *Bombus* and other bees or wasps, on opening the boxes in which their collections were stored have found specimens of *Conopidæ* which emerged sometimes over six months after the killing and pinning of the host.

Regarded as types of parasitic lives, the lives of the larval Conopids are of special interest because they are the first family which are parasitic in the bodies of adult insects. In the previous dipterous families the larvae have been parasitic in the bodies of other larval insects. In the *Conopidæ* the adult Hymenopteron is parasitized by the larval Conopid. Whether the parasite must be more highly specialised successfully to deposit an egg upon an imago as distinguished from a larval host is a matter for consideration. It does not appear to be the case that insects which are highest in the evolutionary grade become parasitic on the higher types of host; and the *Tachinidæ* which come next in the methodus of dipterous parasites are insects whose parasitism is apparently always confined to the early stage of other insects.

(*To be continued.*)

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* References to early observers from the time of Latreille (1809) will be found in Brauer's paper (1883) Denks. Kais. Ak. der Wiss. Wien. Vol. 47. p 83.

† Some details on the life-history of a species of a *Conops* which is parasitic on a large *Pompilus* are given by Saunders "Observations on the habits of the Dipterous genus *Conops*." (1858) Trans. Ent. Soc. London N. S. Vol 4. p. 285.